

Curtis Senior High School Math Team

“... a general and uniform system of public schools.”

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Introduction:

Problem Statement- This year's Team Project question prompted students to evaluate the extent to which, "...a general and uniform system of public schools" is established and maintained throughout Washington State. The central question required students to analyze the different characteristics, conditions and results that are particular to high schools that serve the children who are poor versus high schools that serve children who are not poor, allowing any distinctions between schools that are not general and uniform to be observed and evaluated. Five of these variables were specified in the prompt, while others were designated for the teams to decide. The high schools to be analyzed were determined by the Free and Reduced-Price Meals (FRPM) program; Students must find the high schools that serve high poverty level students ($\geq 70\%$) and high schools that serve low poverty level students ($\leq 15\%$).

Methodology- Our team's first step was to thoroughly analyze the prompt's central question and brainstorm additional variables. In addition to the required variables, number of core academic classes, percent of students attending college, student to teacher ratio, and gender were all variables that our group decided to include.

At first, we simply used the report card generator to find the schools that met the criteria for the FRPM percentage. Once we had gathered all of the schools, we began to input the data, which included the required variables, the chosen variables, and the FRPM values. When making the spreadsheet, we found that although the schools currently meet the FRPM eligibility, some of them did not meet the requirements during the 2012-2013 school year, which was the time frame which we needed to collect the data from since it was the last year that schools began to transition to "Smarter Balanced" exams. We found that on the website, there is an excel sheet for 2012-2013, labeled "Demographic Information by School," showing all information given by the website for each school.

Once we downloaded and opened the excel sheet, we first ordered the data by lowest to highest number of students in each school using the sort generator tool. After, we deleted all the schools that had less than 300 students. We then ordered the data again from low to high by their FRPM level and deleted all the schools that were between 15-70% FRPM and all the non-high school institutions. We also checked that each only served students from 9th-12th grade to get a more accurate data set. Gravity High School was also taken out due to the lack of data provided.

Once we had all the schools meeting the FRPM criteria, we began to input the data using a spreadsheet made in Google Sheets so that all members can work on the sheet at the same time. From this point, we started to split into several groups: statistics, report, and the pamphlet group. In order to address the problem, we needed to know if the FRPM value has any relationship with the variables. Therefore, we used various statistical methods such as scatter plots, t-tests, box plots, pie charts, and chi-square test of significance to determine if there was a difference in the educational attainment of the two groups.

Variables:

Required

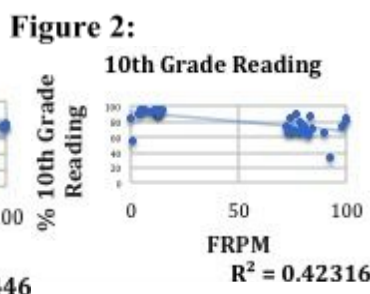
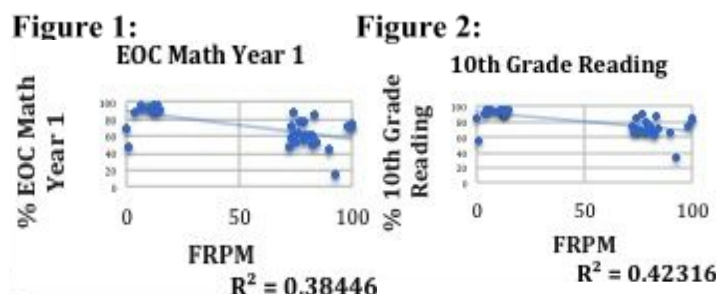
- Test Scores: End-of-Course (EOC) Math Year 1, and 10th Grade Reading
- Average Years of Teacher Experience
- Adjusted 5-year Cohort Graduation Rate
- Race/Ethnicity
- Percentage of Students Who Are in the Transitional Bilingual Program

Extra Variables

- Number of Core Academic Classes: We chose this variable because we wanted to see if the FRPM percentage plays a role in the number of core academic classes available. We ended up taking this variable out because after calling the OSPI office, we found that the data provided had a number of variables that did not allow comparison.
- Percent of Students Attending College: We chose this variable to see if FRPM plays a role in the rate at which the students are prepared to attend college.
- Student to Teacher Ratio: We decided to analyze the student to teacher ratio at each school because it shows class size and ability of teachers to assist students which may impact performance.
- Gender: We chose this variable to see if there is a difference in performance between genders.

Analysis:

- **Test Scores** (End-of-Course (EOC) Math Year 1 and 10th Grade Reading)



Standardized test scores can be used as a measure of comparison for school district performance. Therefore, we decided to graph the data from EOC Math Year 1 and 10th Grade Reading in a scatterplot against the FRPM on the x-axis to find if the %FRPM has a

relationship with the EOC test scores. In addition, we also added a regression line and calculated the R^2 (shown in Figures 1 and 2). From the R^2 , we then calculated r , the correlation coefficient used to represent the relationship between two variables. We received -0.620 and -0.651 for EOC Math and Reading, respectively. Based on these values, there is a moderately strong relationship between test scores and the %FRPM. The lower correlation may be due to a few outliers, which we decided to remove on both graphs resulting in r -values of -0.784 and -0.819 for Math and Reading scores, respectively. These are strong values for this small sample size so we concluded that as the %FRPM increases, both EOC Math and Reading test scores lower.

We wanted to determine if there is a difference in the mean scores between the two groups so we did a 2-sample t-test. Our null hypothesis was the mean (EOC Year 1 Math or Reading) score for the $<15\%$ FRPM group and $>70\%$ FRPM group are the same. The alternative hypothesis states that the two FRPM groups do not have the same test scores. There are certain conditions with regards to running a two-sample t-test:

1) A random sample was taken. Due to the small number of schools available, we assumed the data represented a random sample.

Figure 3:

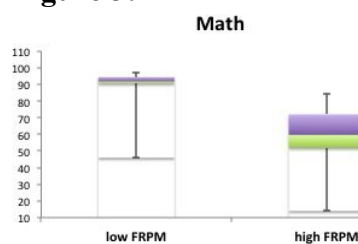
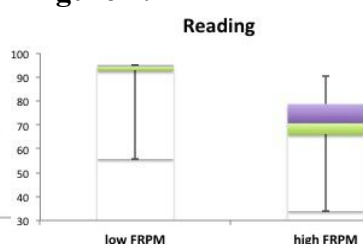


Figure 4:



2) The sample distribution is normal when sample size is greater than or equal to 30. To address this criteria, we created box plots for the data sets for the 15 and 70% FRPM groups, shown in Figures 3-4. Based on the graphs, we don't have strong skewness, but there

were a couple of outliers.

3) Observations are independent and we can assume that each school wouldn't affect another so this condition was met.

We did a two-tail test for all situations and received a p-value of $<.0001$ for both EOC Math and Reading scores. The p-value is the probability of obtaining another sample of the same size that is as extreme or more extreme. Since our p-values are below the alpha levels of .01 or .05, we can conclude that the mean score for schools below 15% FRPM and greater than 70% FRPM are not the same, thus rejecting the null hypothesis. In other words, there is a difference in the EOC Math and Reading test scores between the two groups, rejecting the statement of uniformity in the Washington state public school system.

- **Race/Ethnicity**

Figure 5:

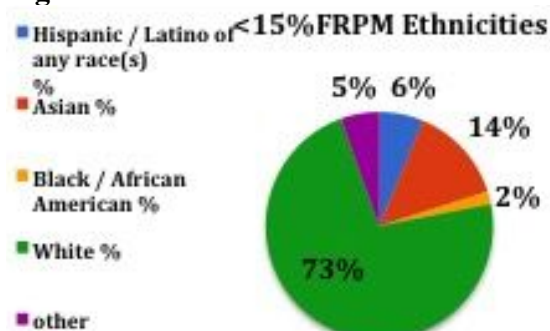
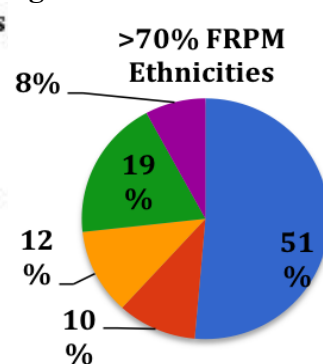


Figure 6:



By observing the pie charts in Figures 5 and 6, there is a distinct difference between the low and high %FRPM schools in ethnicity distribution. The greatest difference between the two graphs is that there is a mean percentage of 73% in White for schools with <15%

FRPM. On the other hand, in the >70% FRPM schools, the Hispanic/Latinos population is a mean of 51%. The charts also show that >70%FRPM schools have more diversity since the ethnicities, other than Hispanic/Latino, represent the other half of the chart relatively equally.

Table 1:

	Hispanic/Latino	Asian	Black/African American	White
EOC Math <15	8	9	0	13
EOC Math >70	8	4	4	6
10th Grade Reading <15	10	12	0	17
10th Grade Reading >70	12	5	6	9

*when the ethnicity is greater than 5% and the pass rate was greater than 70%

We then did a chi-square test (Table 1) using the four most prevalent ethnicities, Hispanic/Latino, Asian, Black/African American, and White, and the EOC Math Year 1 and 10th grade reading test scores. The null hypothesis is that there is no association

between ethnicity and schools passing EOC Math and Reading tests. The alternative hypothesis is that there is an association between ethnicity and pass rate for the two FRPM groups. For this, the condition set was ethnicity higher than 5% and greater than 70% of the students passing the test. The results from the chi-square test, a chi-square number of 18.407 and p-value of 0.0307, show an association between ethnicity and school performance on standardized reading and math tests, leading us to conclude that the >70% FRPM schools which had a higher percentage of Hispanic/Latino and overall diversity, as shown by the pie charts in figures 5 and 6, have a lower pass rate. Therefore, ethnicity is a variable that clearly demonstrates nonuniformity in the public school system.

Using the OSPI report card website, we also found trend lines (Figures 7-10) that represent the performance on 10th grade reading and EOC math year 1 tests in Washington state for White and Hispanic ethnicity over the years. By observing these we can further conclude if the results we found in the chi-square test accurately represent the uniformity of schools in general or if the results are only applicable to the 2012-2013 school year. In observing the trend lines, we find that the trends are very similar between ethnicities, but the White ethnicity consistently has higher results than Hispanics. This emphasizes the conclusion that the <15% FRPM schools, which have a high percentage of Whites are performing better than the >70% FRPM schools, which have a high percentage of Hispanic/Latinos. Improvement of test scores over the time period have not lessened the gap between ethnicities and their nonuniform results. Trend lines for the four most prevalent ethnicities were examined and the Asian and White ethnicities, which both make up a higher percentage of the population in the <15% FRPM schools, consistently had higher test scores than the Hispanic/Latino and Black/African American ethnicities, which are more predominant in the >70% FRPM schools.

Figure 7: (White)



Figure 8: (Hispanic/Latino)

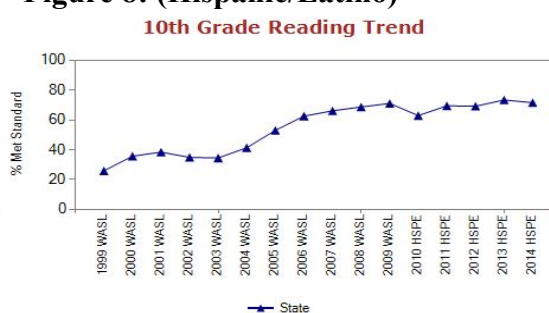


Figure 9: (White)

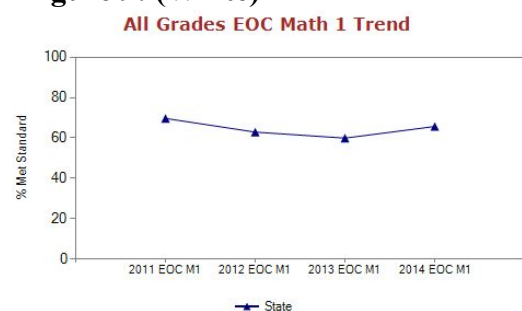
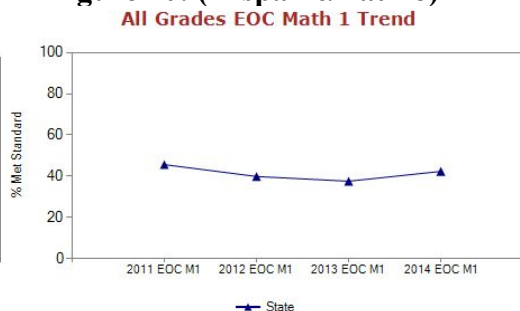
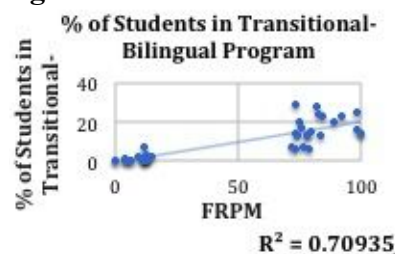


Figure 10: (Hispanic/Latino)



● Students in Transitional-Bilingual Program

Figure 11:

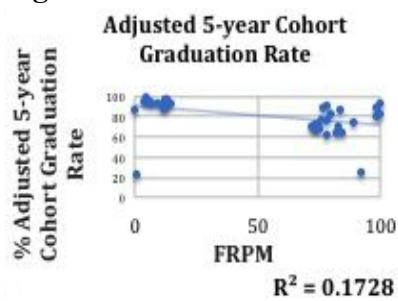


The correlation between percent of students in transitional-bilingual programs and %FRPM was .8422. Based on this value, there is a strong relationship between the percent of students in the transitional-bilingual program and the %FRPM. The positive relationship is probably because the >70% FRPM schools have more students that identify themselves in an ethnicity that would normally speak a different language. For instance, the >70% FRPM schools have an average of 51% Hispanic. That is a significant number of students which would likely speak Spanish at home, thus leading to a higher percentage of students in the Transitional Bilingual Program in those schools.

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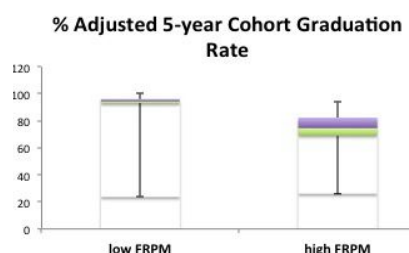
- Adjusted 5-year Cohort Graduation Rate

Figure 12:



Again, once the correlation was calculated, we received a value of -0.4157 . By observing the graph in Figure 12, there could be a possible association. Thus, we took out the outliers, the two points on the graph with the lowest percent adjusted 5-year cohort graduation rates. After doing so, we received a much higher r -value of -0.6969 . Considering that we have a small data set, we concluded that there is a moderately strong relationship between FRPM and adjusted 5-year cohort graduation rate.

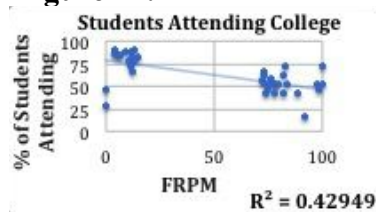
Figure 13:



Again, we conducted a t -test to compare the means of the two extreme ends on the FRPM scale. Our null hypothesis was that the means of the low FRPM and high FRPM groups are the same. The alternative hypothesis stated that the two are not the same. We found the p -value to be $.003$, rejecting the null hypothesis, which means there is a difference between the high and low FRPM adjusted 5-year cohort graduation rates.

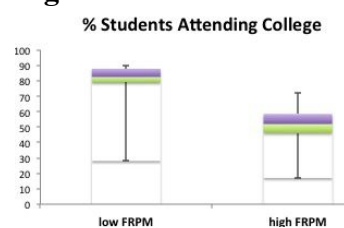
- Percent of Students Attending College

Figure 14:



Our resulting correlation was -0.6554 . There is clearly a negative trend between the groups by just observing the graphs. Because the graph in Figure 14 shows that there seems to be 3 outliers, the points were taken out. This increased the r -value to -0.8614 . Thus, we concluded that there is a moderately strong association between %FRPM and percent of students attending college.

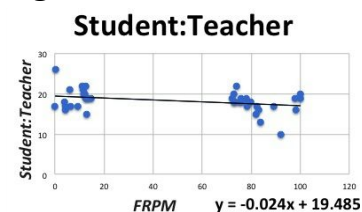
Figure 15:



Again, we ran a t -test to see if there was a difference in the means. Our null hypothesis was that the means of percent of students attending college for $<15\%$ FRPM group and $>70\%$ FRPM group are the same. Our alternative hypothesis said that the two groups are not the same. We found the p -value to be $<.0001$, thus rejecting the null hypothesis, which means that there is a difference between the high and low FRPM with respect to percent of students attending college.

- Student to Teacher Ratio

Figure 16:

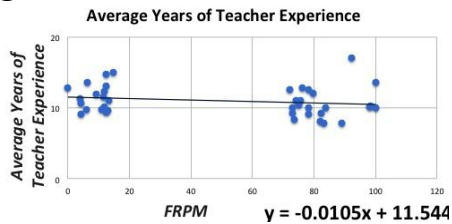


We calculated the correlation to be -0.3397 , stating that there is weak, negative association between student to teacher ratio and the %FRPM. Along with this low correlation value, we found that the ratio is fairly consistent based on the regression line and the means. The slope of the graph is nearly 0 indicating a horizontal line and no relationship between the variables student to teacher ratio and

%FRPM. This exemplifies uniformity between low and high FRPM schools in regards to student to teacher ratio.

- **Average Years of Teacher Experience**

Figure 17:



By simply observing the graph in Figure 18, there is an obvious uniformity between the %FRPM and average years teacher experience. With an r-value of .19, we concluded that there is uniformity based on the trend line and the means. Like student to teacher ratio, the slope of the average years of teacher experience is close to 0, indicating that the line is almost horizontal, showing that the data is consistent. Moreover, the average for the low and high FRPM for this variable is about 12 and 11, respectively.

- **Gender**

Figure 18:

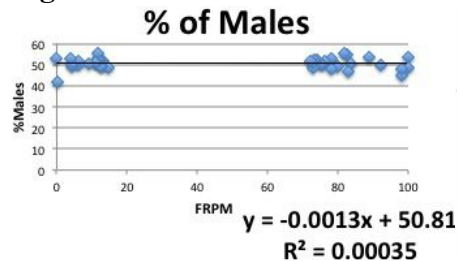
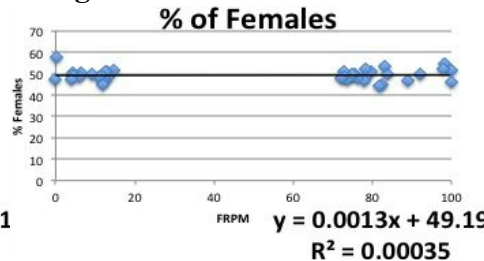


Figure 19:



We found that both percent of males and females' r-values are .0187, showing that there is little to no correlation between the FRPM and gender. However, in

examining the graphs from Figures 19-20, we can see that schools all in all maintain an equal ratio of about 1:1 of males to females. Additionally, the average percent for both males and females on both high and low FRPM is about 50%.

The uniformity of student to teacher ratio, average years of teacher experience, and gender meant that these variables had no relationship between %FRPM. The means analyzed for the low and high poverty groups show no difference for the three variables.

Conclusion:

Overall, schools with high FRPM have lower test scores, 5-year cohort graduation rates, and students attending college. Moreover, they have more diversity and students in the transitional bilingual program. In the end, we found that student to teacher ratio, average years of teacher experience, and gender were variables that maintained consistency in both the high and low FRPM schools.

Therefore, due to these several factors, schools that serve the rich (<15%FRPM) have characteristics, conditions, and results that are inconsistent from schools that serve the poor (>70%FRPM). We can conclude that the charge made by the Constitution that there be a "general and uniform system of public schools" "without distinction or preference on account of race, color, caste, or sex," is not being achieved based on the data from 2012-2013.

Appendix:

Table 2: Data for schools with $\leq 15\%$ FRPM

Schools 15% and below FRPM	% FRPM	Hispanic / Latino of any race(s) %	Asian %	White %	Black / African American %	other %	% of Students in Transitional-Bilingual Program	% Adjusted 5-year Cohort Graduation Rate	Average Years of Teacher Experience	Core Academic Classes	% EOC Math year 1	% 10th grade reading	% of Students Attending College	Student : Teacher	Male %	Female %
Inglemoor HS	14.62	8.21	16.2	67.7	2.3	5.6	2.3	94.2	15	632	90.9	94.4	82	19	48.52	51.48
Newport Senior High School	13.19	4.65	40.6	44.6	2.2	7.9	0.8	96.7	11.1	399	94.7	95	90	19	51.55	48.45
Liberty Sr High School	12.92	9.02	12.5	72.3	1.9	4.2	0.8	95.6	9.7	404	suppressed	93.5	81	15	49.18	50.82
Redmond High	12.53	9.8	14.5	69	1.4	5.2	3.1	93.4	9.4	711	90.7	91.3	83	22	49.31	50.69
Gig Harbor High	12.42	4.6	1.8	84.9	1	7.9	0	92.8	14.7	677	93	93.3	80	19	52.41	47.59
Mount Si High School	12.26	4.7	3.3	89.2	1.1	1.8	0.4	90.2	13.1	472	suppressed	95	66	20	52.32	47.68
Woodinville HS	11.9	8.3	7.8	77	1.7	5.3	1.6	95.9	12.3	525	95.2	94.8	79	20	53.21	46.79
Bellevue High School	11.84	5.8	26.7	58.1	3.2	6.1	7.4	97.1	10.1	387	95.5	92.4	88	20	55.39	44.61
Tahoma Senior High School	11.45	7.3	3.5	80.4	2.5	6.4	0.2	89.5	11.6	283	90.5	95	72	21	50.99	49.01
Glacier Peak High School	10.96	6.3	7.7	78.3	1.6	6	0.5	93.9	9.8	367	91.6	95	79	22	51.21	48.79
Issaquah High School	9.1	6.8	18.4	67.9	1.7	5.2	2	94.3	11.9	492	92.9	93.9	88	17	50.37	49.63
Bainbridge High School	6.31	4.6	4.5	85.9	0.6	4.4	0.3	94.3	13.6	563	95.1	95	85	17	49.6	50.4
Eastlake High School	6.11	6.9	11.3	77.3	1.2	3.4	0.1	95.8	9.8	552	91.8	95	84	21	51.56	48.44
International School	4.36	2.5	32.7	54.3	0.7	9.8	0	100	10.7	142	suppressed	95	87	17	49.47	50.53
Skyline High School	4.2	5.3	22.9	65.6	2.4	3.7	0.6	96.2	9.1	485	suppressed	95	90	16	50.63	49.37
Mercer Island High School	3.87	2.9	19.9	73.7	1.4	2	1.1	96.3	11.3	646	88.1	90.4	89	18	52.9	47.1
Insight School of Washington	0.24	10.84	2.96	72.99	4.93	8.25	0	23.6	not provided	257	45.9	55.7	28	26	42.05	57.95
Eatonville High School	0	5.6	0.3	86.9	1.4	5.6	0	87.3	12.9	229	69.5	84	47	17	52.72	47.28
Average	8.793	6.340	13.753	72.561	1.846	5.486	1.178	90.394	11.535	456.833	87.529	91.317	77.667	19.222	50.744	49.256
Standard Deviation	4.659	2.279	11.420	11.836	1.019	2.110	1.793	16.936	1.840	162.162	13.625	9.298	16.215	2.647	2.778	2.778

Table 3: Data for schools with $\geq 70\%$ FRPM

Schools 70% and above FRPM	% FRPM	Hispanic / Latino of any race(s) %	Asian %	White %	Black / African American %	other %	% of Students in Transitional-Bilingual Program	% Adjusted 5-year Cohort Graduation Rate	Average Years of Teacher Experience	Core Academic Classes	% EOC Math year 1	% 10th grade reading	% of Students Attending College	Student : Teacher	% Male	% Female
Toppenish High School	100	88.1	0.3	3.5	0	8.1	14.2	93.7	10	180	73.8	81.6	52	20	48.36	51.64
Royal High School	100	78.7	0.5	20	0.5	0.4	14.2	82.2	13.6	133	71.9	84.6	72	19	53.65	46.35
Wahluke High School	98.19	95.5	0	3.5	0	1	25.4	81.7	10.3	196	suppressed	suppressed	47	16	45.19	54.81
Wapato High School	98.03	76.3	1.9	4.4	0.2	17.2	16.2	89.5	10.1	173	70.5	75	52	19	47.76	52.24
Stanton Alternative School	92.2	76.1	0.3	15.1	2.3	6.3	23.4	26	17.1	132	14	33.9	17	10	50	50
Granger High School	89.02	89.7	0	5.6	0	4.7	19.8	75.8	7.9	93	44.8	65.8	42	17	53.36	46.64
Rainier Beach High School	83.79	14.1	19.8	4.7	52	9.5	22.8	63.6	10	224	52	70.1	52	13	50.21	49.79
Health Sciences & Human Services	83.06	35.4	31.1	10.7	11.3	11.5	12.8	87.7	7.8	120	85.7	88.5	72	16	46.7	53.3
Global Connections High School	82.42	38.6	21.6	12	12.9	15	24	71.2	9.2	160	59.7	63.1	62	17	54.96	45.04
Academy of Citizenship and Empowerment	81.89	38.3	15.5	11.5	18	16.7	28.3	64.3	8.1	131	50.5	65.3	42	15	55.71	44.29
Davis High School	79.79	81.8	0.8	12.7	1.1	3.6	15.4	82.4	12.1	682	59.2	74.2	52	18	49.25	50.75
Lincoln	78.28	25.4	15.4	26.3	26.9	6	6.1	62	12.6	507	59.6	67.6	52	17	51.52	48.48
Grandview High School	78.2	86.8	0.5	12.1	0.1	0.5	12.8	91.7	10	194	55.7	78.7	52	18	47.86	52.14
Clover Park High School	78.11	37.2	7.6	23.4	14	17.7	13.5	75.9	9.1	442	77.9	65.5	42	19	53.15	46.85
Rogers High School	76.31	9.7	4.6	63.2	4.4	18	7.4	89.1	12.8	549	76.9	90.6	59	18	51.82	48.18
Quincy High School	75.66	82.7	0.4	16.8	0	0.1	16.6	76.7	11	184	63	69.6	52	19	50.13	49.87
Pasco Senior High School	75.04	77.1	1.3	17.9	2	1.6	19.8	69	10.4	673	52	69.3	46	18	50.4	49.6
Sunnyside High School	74.04	19.5	15.7	35.8	22.6	6.4	13.5	70.6	11.1	697	61.1	70.7	43	22	52.14	47.86
Cleveland High School	73.41	11.2	39.7	5.7	37	6.3	6	68.6	8.3	402	88.8	84	67	18	52.49	47.51
Fort Vancouver High School	72.92	26.7	4.5	54.1	5.4	9.4	14	73.4	10	493	57.4	71.5	55	18	48.72	51.28
Foster Senior High School	72.86	22.2	31	19.5	19.4	7.9	29.4	70	9.3	369	70.8	65.9	62	20	51.19	48.81
Mt Tahoma	72	19.5	15.7	35.8	22.6	6.4	7	71.4	12.6	531	47.9	73.7	57	19	51.83	48.17
Average	82.51	51.39	10.3	18.9	11.49	7.92	16.48	74.39	10.61	330.23	61.58	71.87	52.23	17.55	50.75	49.25
Standard Deviation	9.49	31.06	12.10	15.98	14.08	5.90	6.92	14.33	2.19	207.56	16.36	11.84	11.90	2.52	2.67	2.67

Table 4: Standard Deviations of both the high and low FRPM combined

	% FRPM	Hispanic / Latino of any race(s) %	Asian %	Black / African American %	White %	other	% of Students in Transitional -Bilingual Program	% Adjusted 5-year Cohort Graduation Rate	Average Years of Teacher Experience	Core Academic Classes	% EOC Math year1	% 10th grade reading	% of Students Attending College	Student : Teacher	Male %	Female %
Stand ard Devia tion	37. 9	32.20	11. 8	11.4 4	30. 5	4.7	9.31	17.34	2.07	196.8	19. 87	14.4 6	18.85	2.68	2.7	2.7

Resources

"Washington State Report Card." *Washington State Report Card*. Web. Feb. 2016.